50X1-HUM

Next 3 Page(s) In Document Denied

V.Y. Mikhailov STAT

THE USE OF COLOUR SENSITIVE FILMS IN AERIAL PHOTOGRAPHY IN U.S.S.R.

I. Aerial photography

I. Colour pictures have come to be widely used in the U.S.S.R.

In aerial surveying two types of negative film are employed at present: the three-layer film enabling the image to be obtained in colours closely resembling those of the objects recorded, and the two-layer, or spectrozonal, film producing an image in arbitrary, contrasting colours which greatly facilitates the interpretation of a variety of detail. The former (designated as CN) has the usual structure of its kind; its spectral characteristic curve is shown in Fig. 1. The sensitivity of the CN-1 film formerly used was the same as that of black-and-white film of 15 DIN; it is being superseded by the CN-3 film whose speed is 20 DIN (70 unit of GOST as a minimum[x]) and Gamma (γ) approximating 1.0.

The spectrozonal film (SN-2) is made of two layers only, the sensitation maximum of the lower one, which is panchromatic, being reached at = 650 mu, while that of the upper, which is infrachromatic, is attained at = 735 mu. (Fig. 2). There is no yellow layer between them, so the use of a yellow or orange-coloured filter becomes a must when taking photographs. Upon development the upper layer shows light blue and the lower is rendered magenta. The speed of this film exceeds that of the CN-3 about 50-100 per cent, and its Gamma (γ) is 2.0. Owing to vast territories of wooded land being surveyed in the U.S.S.R. the SN-2 film is more widely used as compared with the CN film. Experience has shown that pictures taken on the SN film, i.e. those obtained in arbitrary colours, make the identification of a variety of detail much easier; moreover, since light filters may be employed, it is possible to take photographs from considerably higher altitudes. In this connection research is being made on the feasibility of using other spectrozonal films with different spectral characteristics and with a different distribution of colour-forming components. (1).

In the positive processes the "Phototsvet" ("Photocolour") paper of the usual kind is used. It is available in two grades, viz. the normal (γ is in the neighbourhood of 1.5) and the one with an enhanced contrast (γ is about 2.0). The positive film of the same kind is not used as frequently. Spectrozonal colour film (SB) and the positive two-layer film (SP) are also available; they are used in printing from spectrozonal negatives. The lower layer is panchromatic and is rendered light blue upon development; the upper is orthochromatic and becomes magenta-coloured; the intermediate yellow filter layer is absent. In spite of special positive papers for printing from spectrozonal negatives being available, it is common practice to print them on three-layer papers, for the yellow layer enchances the variety of tones.

x) GOST - National Standards of U.S.S.R.

2. For colour photography the same cameras are used as for black-white; it is advisable to employ conventional lenses. When using wide-angle (2B = 100° or 120°) cameras, neutral "shaders"[x]) should be introduced the density distribution of which is the reciprocal of the light distribution in the field of view. Light filters are indicated only for the SN-2 film, which makes it suitable for taking photos from high altitudes. The CN - film is used without any filters or with a very faint-yellow one (JS-3), so it is not recommended for flying altitudes exceeding 3,000 - 3,500 meters. A filter of greater density (JS-12) has been experimented upon in conjunction with a film whose spectral characteristic conforms with tungsten lamps (LN-3) (2); the results are satisfactory, but have not yet found their way into practice.

To prevent changes in daylight spectrum from affecting the colour balance it is advisable to take colour photographs when the altitude of the sun is at least 20°.

To avoid flare (diffused light) coated lenses and lens hoods may be helpful.

3. The well known technique for processing colour films, commonly made use of in the treatment of movie films, is hardly practicable in the field. That is why the processing of aerial colour films followsthe method developed at the ZNIIGAI, K[xx] (3). This differe from the one employed in cinematography in what follows.

a. The development of the film is carried out to the end; the "additional" development while rinsing after the development proper is thus dispensed with. The film is developed at once up to the required gamma (γ) value which is controlled by the amount of the developing agent introduced and the length of development. Temperature changes may be considerable but they are allowed for, just as they are in the case of black-and-white films.

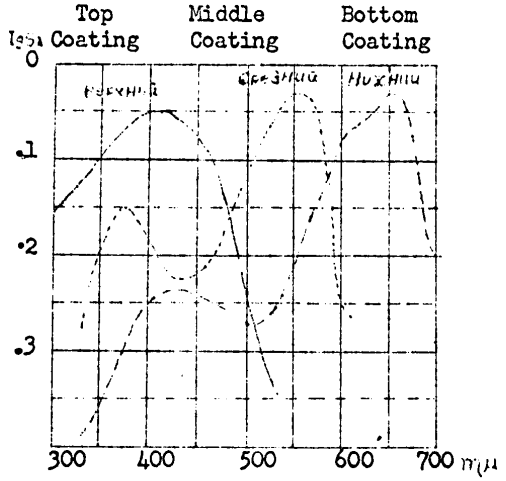
b. The formula for the developer has been modified to a certain extent. The same agent (ethyloxyethylparaphenylenediamine) serves in both the negative and the positive processes; it is introduced into the stored solution just before starting the development. Sodium carbonate is substituted for potassium carbonate because it is more handy in the field. Potassium bromide is all but dispensed with; a much more effective buffer is used instead, viz. benzotryanol, the quantity of which may be 3 to 15 milligrams per litre. The optimum quantity for any particular case is found by trial before doing the actual work. As this buffer prevents fogging, one can, by prolonging the time of development, get a higher emulsion speed than that obtainable when using potassium bromide. (Fig. 3).

c. A strong hardening bath is used, so colour films can be processed in any regions, even when the temperature is high. A film will stand development without hardening up to 30° Centigrade. Upon development it is transferred to a solution containing 0.5 per cent of acetic acid and 5 per cent of hypo (sodium sulphate); after this is immersed in a 1 per cent chrome-alum solution. This results in so high a degree of hardening that the film will stand hot water without any detriment to the colour balance.

---

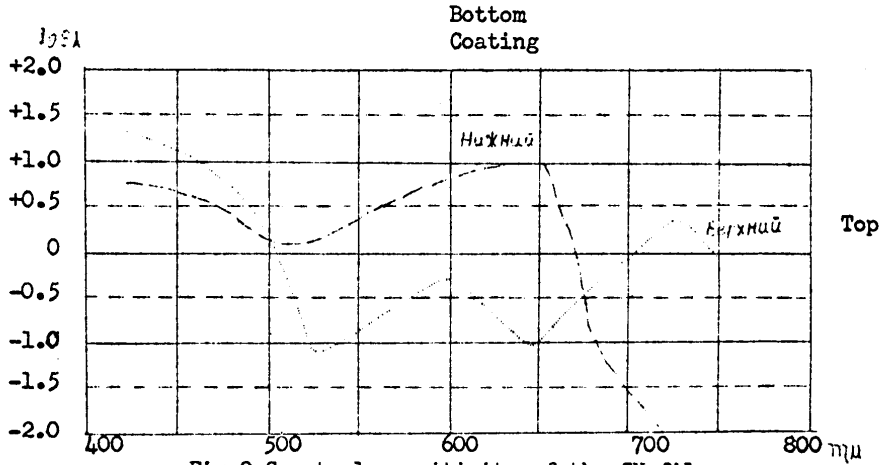
x) Filters casting shadows on to the image plane.

xx) The Central Research Institute of Geodesy, Aerial Surveying and Cartography.



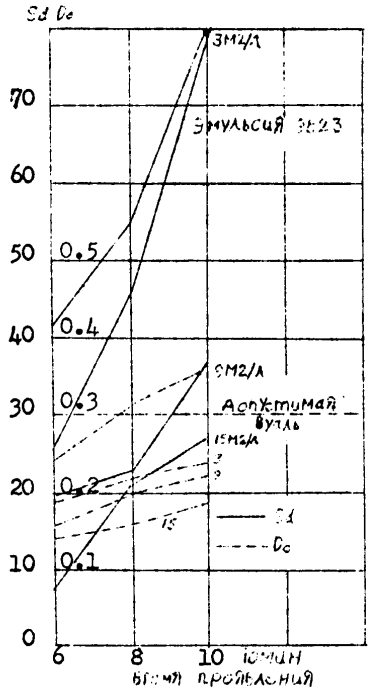
Log. Sensitivity?

Fig. 1 Spectral sensitivity of the CN-film



Top Coating

Fig 2 Spectral sensitivity of the SN-film



3 milligrams per litre

Emulsion 9823

9 milligrams per litre

Acceptable fogging

15 milligrams per litre

Minutes
Development Time

Fig. 3 The variation of speed and fog with different amounts of benzotriazol.

STAT

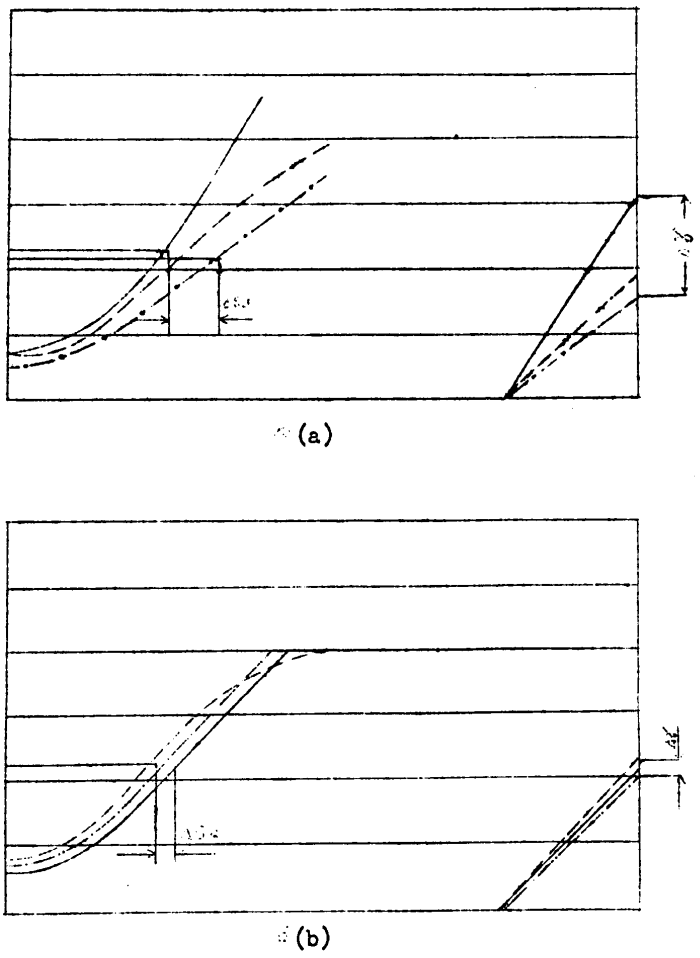


Fig. 4 a - without iodine
b - 0,12 gr of iodine per litre

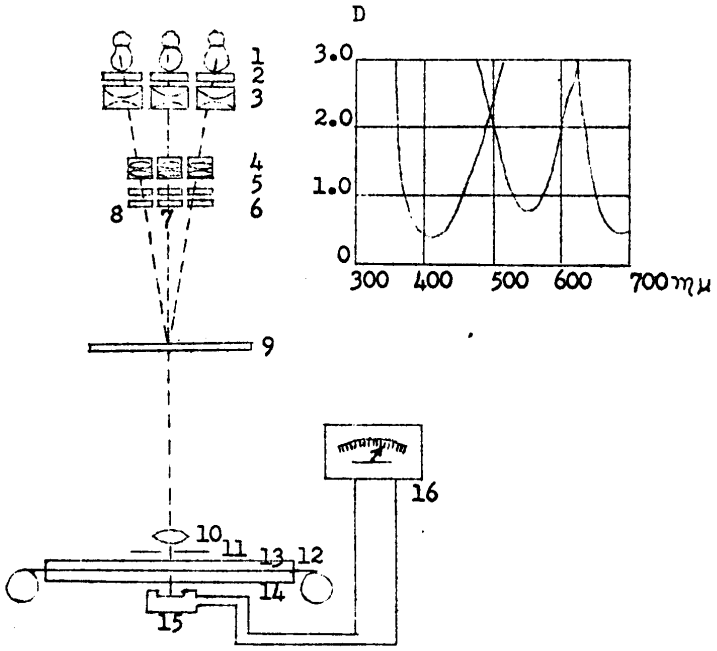


Fig. 5 The scheme of the additive printer (copying apparatus)

1 - the light source

2 - Heatfilters

3 - condensors

4 - lenses

5 - aptical wedges

6, 7, 8 - filters; their spectral characteristics are shown in curves

9 - adiffusing plate

10 - a lens used by the measuring process

11 - a stop

12 - the film

13 - pressing glass

14 - ground glass

15 - photocell

16 - galvanometer

d. To speed up work, the between-the-baths rinsings have been curtailed to 2 minutes. Therefore, to avoid the appearance of fog in the course of subsequent treatment, hardening is followed by an acid fixing bath after which comes bleaching.

The recipe for the succeeding baths has been simplified.

e. Some substances having a particular effect on the photographic properties of the image are introduced. When the colour balance suffers owing to the greater speed of the upper layer, an alcohol solution of iodine is added in amounts depending on the rate of the loss of balance, but not exceeding 0.2 gr. per litre. (Fig. 4). When there is underexposure it is advisable to add tallium salts in 1 gram per litre concentration whereby emulsion speed becomes doubled, and Gamma increases $1\frac{1}{2}$ times. Some falling off of colour balance occurs then but is kept well within permissible tolerances.

f. It is advisable to perform the development using coils (spirals), for the application of spool winding appliances results in an undue lengthening of the negative process. In general the ZNIIGAIK method reduces the time of processing to 32-35 minutes instead of the usual 55 minutes.

4. Printing from aerial negatives is done with subtractive filters or with three additive filters (4). Thanks to the convenient design of the additive printer (copying apparatus) (Fig. 5) which enables the desired spectral composition of the printing light to be obtained by means of a photocell, such devices are on the way to superseding the subtractive machines in spite of the latter being comparatively simpler in operation. The assessment of colour reproduction on spectrozonal films is based on the maximum colour gradation in the photo images of the main subjects. For prints from three-layer films the criterion is the quality of reproducing the natural colour tones of the objects photographed, i.e. the colours of the images as compared to those of the objects viewed from the ground. This way of approaching the problem of selecting tones is justified by the fact that when the country is viewed from some height some levelling-out of colour contrasts always takes place.

In processing prints the same solutions are used as in the negative process.

5. The entire process of colour photography is carried out under control. There is a National standard for testing negative materials. By means of a special device a sensitometric wedge is printed on every film to be developed. When the film has been developed, the wedge densities are measured with the aid of a photoelectric densograph; as a result, characteristic curves are obtained for each layer, and the mean value of the contrast factor (Gamma) is obtained. The overall density of negatives that are representative of the film under consideration is measured on a special densitometer. The specifications for good quality three layer films are as follows: according to the type of the country, γ may be from 0.9 in mountainous regions, where sharp differences in brightness values occur, to 1.8 in areas of low relief.

The γ value of spectrozonal negatives is 0.4 - 0.6 higher than that of three-colour ones. The mean density of negatives may vary from 0.6 up to 1.2.

Investigations have shown that, though having a lower resolution, colour pictures are in no way inferior to black-and-white photos as regards their photogrammetric properties and the structure of the developed layers; on the other hand, they do not induce so much eye strain when used in stereoscopic instruments. That is why they are used both for interpretation and photogrammetric purposes.

It would be premature to make any definite statements on the economical effectiveness of aerial colour photography. The negative process calls for little, if any, additional expenses; it is the positive process, that raises the cost; colour-paper being much more expensive and the procedure more laborious. The increase in the total cost of an aerial survey must be about 10-20 per cent.

II. The Use of Aerial Colour Photographs

In forest and tundra studies spectrozonal aerial photos are most commonly adopted. As a result, the greater part of interpretation process has become office work. On spectrozonal photos not only the kind of wood but also in some cases the age of the trees is identifiable. Fir forest stands show dark green, pine - green, birch - greenish-yellow, oak - yellowish-brown, aspen - brownish red, etc. The vegetation in clearings and areas left after wood fire, as well as in swamped places is quite distinguishable. Moreover, the surface of the earth that is under the canopy of tree foliage stands out better on spectrozonal photos due to the difference in colouring between the surface vegetation and the tree-tops. This is also true of streams and damp places. Tundra landscapes produce a multicoloured effect on spectrozonal pictures: the polar birch shows greenish brown, the willow - dull brown, moss looks dark green, lichens come out light green, while moss-and-peat bogs are bright green, and grass marshes yellow-green.

Aerial photography is executed for forestry purposes on several scales of which the most common is 1:25,000.

The greater cost of colour pictures is offset by both an improvement in the quality attained and by a reduction in ground work required. For instance, when mapping forest and tundra areas that are difficult of access the use of spectrozonal films enables the amount of interpretation in the field to be greatly reduced as compared with the cases when black-and-white pictures are employed; it should be noted that the cost of field interpretation is three or even four times as high as that of aerial photography proper.

By employing spectrozonal photos in forestry a good deal of money was saved as against the estimate that had provided for the use of black-white films.

In geological investigations both the CN and the SN-2 films are used, but the former is more frequently preferred for the reason that it is much easier to identify the kind of rock or soil on prints where their natural colours are reproduced.

Summer landscapes in sand deserts are characterized by a lack of colours; so when dealing with them three-layer films are preferable, for details that are hardly discernible on black-and-white photos stand out fairly well on colour prints. Brownish-greys and greyish-yellows are characteristic of different kinds of sand. The optimum zone for sandstone is the visible part of the spectrum within 520-600 m.

Sparsely growing shrubs show as greenish dots. In general, colour photographs enable the morphological type and the consolidation of the sand to be identified as well as shrubs, semi-shrubs (possible of classification into groups) and surface details, e.g. paths. For unwooded mountainous areas as well as alpine landscapes three-layer films can be used to advantage. Not only differently tinted outlines of bare rocks and grass covered slopes or the structure of ice field surface are identified more easily and in fuller detail on these films, but also paths and features obscured by shadows can be recognized. These latter are generally lost on spectrozonal photographs because the application of dense filters, which is unavoidable with such films, prevents them from being affected by the short-wavelength region of the spectrum, which is the very one characteristic of shadows. For wooded mountainous areas the CH-2 film is employed.

It is common practice with geologists to resort to spectrozonal films whenever the territory to be photographed happens to be covered with vegetation typical of the soil or underlying rock.

The CH-2 film may also be recommended in many cases of soil studies, differences in moisture content, humus components etc. being easily distinguishable on it; but colour films are by no means infrequently used either.

Aerial colour photography using various films is also executed in town surveys, surveys of agricultural areas, for planning railway lines, designing hydrological projects and for a variety of other purposes.

In conclusion the problem of some rivalry between the black-and-white and the colour films should be mentioned. The former is still the more commonly used in aerial photography in spite of the ever growing part played by the colour-films, because the latter are only employed where their advantages over the black-white films are self-evident. In a number of cases it is a good plan to make black-and-white prints from colour films for this results in a better rendering of details than is attained with black-and-white negatives.

It should also be added that colour films have become widely used in aerial surveys in the U.S.S.R.; the scope of colour air surveys is steadily growing, there being a notable rise both in the quantity and the quality of work done.

REFERENCES

1. A.N. YORDANSKY - I. The Uses and Principles of Spectrozonal Photography.
   Zhurnal nauchnoi i prikladnoi fotografii i kinematografii (The Journal of Scientific and Applied Photography and Cinematography), Vol. II, No. 1, 1957.
   II. Chromatic and Achromatic Details of Darkening x) as as Measure of Spectrozonal Images Mutually Aiding to Make Themselves Appreciable.
   Ibid, Vol. III, No. 4, 1958.

2. V.Y. MIKHAILOV - On the Rational Way of Using the LN 3 Negative Colour Film.
   Ibid, Vol. III, No. 5, 1958.

3. V.Y. MIKHAILOV - The Colorographic Process in Air Photography.
   M.M. TZIGANOV Trudy ZNIIGAiK, Publication 107, 1955.

4. A.N. USPENSKY - Photoelectric Printers for Colour Photos.
   Designer Geodesya i Kartografya (Geodesy and Cartography), No. 9, 1957.

5. V.Y. MIKHAILOV - Results of Employing the Colorographic Process in Air Surveys and Mapping.
   Trudy ZNIIGAiK (The Proceedings of ZNIIGAiK). Publication 107, 1955.

6. L.M. GOLDMAN - The Application of Colour Airphotos in Studying a Terrain.
   Interpretation Specialist Ibid, Publication 137, 1960.

---

x) i.e. the difference in optical densities between two adjacent elements of a photo image.